

Greenwich Times of Egypt Transit of Venus Observations, with remarks as to different Phases and Discordances in Times.

By Captain C. Orde Browne, late R.A.

The following Greenwich times of contact observations of the Transit of *Venus* at the Egyptian stations are given as bearing on the question of the probable discordances between the times of individual observers. As has been repeatedly noticed, the Greenwich times on this station are easily and accurately obtained, because the longitude of the central station on *Mokattam Heights*, Cairo, was got by the exchange of telegraph signals with Greenwich. The longitudes of *Suez* and *Thebes* were obtained by the exchange of signals with Mokattam and that of *Abbasceeyah* by triangulation. That of *Rigaf*, however, is likely to be undetermined beyond the rough results of sextant observations for a long time.

The Greenwich times for all but the last, may be considered final to all intents and purposes. Future scrutiny might lead to some slight modification it is true; for example, if M. Döllén made any final correction of his times on certain nights, it might affect the Thebes longitude directly; on others it might do so indirectly, by modifying the personal equation between him and myself. I am satisfied, however, that no alteration so great as $0^s.1$, is at all likely to be made. For Transit of *Venus* purposes, therefore, the times may be considered final.

Before giving them, I would say a few words on the classification of contact observations; confining myself to bare facts as to differences in the phenomena observed to whatever cause they are attributable.

From what I have seen of reports generally, I should think that the phases of contact may best be divided into three classes.

1st. *Shadow contacts*, including all those where a connexion was observed between *Venus* and the Sun, *decidedly less dark* than the body of the planet, sometimes recorded as a faint or dark shadow, sometimes as interference lines.

2nd. *Black contact*, when the ligament appeared to be solid, and as dark, or nearly as dark, as the body of the planet; in other words, when no light could be detected across the ligament.

3rd. *Geometrical contact* between the limbs of *Venus* and the Sun. In certain cases, the only phase of contact whose time could be definitely noted was the commencement or termination of *shadow*, an observation to which Mr. Stone, I think, attaches special importance.

At Mokattam and Suez, the observation of the shadow was difficult, but "black contact" was distinctly seen and noted by all observers before the perplexing white fringe of light suddenly appeared. Geometrical contact was then a very difficult observation.

At other stations (in Egypt, at Thebes) scarcely any shadow

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or ligament was seen, but geometrical contact was well observed. The fringe of light appeared at different times, both at different stations and to different observers at the same station, the larger glass as might be expected detecting it first. For example, at Thebes, Colonel Campbell, with a $7\frac{1}{2}$ -inch glass, saw it at all events many minutes before Admiral Ommanney, who used half of a 3-inch glass; and at Mokattam, I with a 5.9-inch glass saw it perhaps 30 seconds before Miss Newton with a 3-inch one.

It appears from the cases where more than one kind of contact was recorded, that so long a period elapsed between the different phases, that a careful analysis of observations is necessary, and that it is desirable to take great pains to learn the exact phase recorded in each case. For example, between first shadow and geometrical contact, Mr. Hunter, at Suez, records $2^m\ 18^s$, Mrs. Campbell, at Thebes, $2^m\ 0^s.24$, and Mr. White, at Melbourne, with a $2\frac{3}{4}$ -inch glass, $1^m\ 52^s$.

Between black and geometrical contact, Mr. Hunter has $1^m\ 33^s$; while Miss Newton, at Mokattam, has $1^m\ 25^s$. Mrs. Campbell's "small black drop" at Thebes does not accord with black contact apparently at Cairo and Suez. It was later, and probably very small, for no other observer at Thebes recorded it. Between first shadow and black contact, Mr. Hunter had $45^s.0$; and Mr. White, with a $2\frac{3}{4}$ -inch glass, at Melbourne, $51^s.0$ between first recorded shadow phase and black contact. Mr. Ellery, with an 8-inch glass, records a haze or smoky shadow $2^m\ 22^s.4$ before contact, but a distinct black thread seen 66^s before black contact. There was much cloud, extending nearly up to the Sun, at contact at Cairo and Suez. At Thebes, the sky was quite clear.

At Mokattam Heights I had insisted on "black contact" as the phase of primary importance. The following are the times recorded for it at that station, and at Abbasseeyah, the Egyptian Government Observatory, at the foot of the hill; the director of this, Mahmoud Bey, had consulted with us, and had watched contacts on the Mokattam model.

Mokattam Black Contacts.

	Greenwich Sidereal Time.		
	h	m	s
Mr. Newton ($4\frac{1}{2}$ -inch De La Rue glass)	11	17	14.48
Miss Newton (3-inch glass)			16.79
Capt. Orde Browne (5.9-inch Lee glass)			17.90
Mahmoud Bey (6-inch about)			20.61
Mean	11	17	17.45

I should not give different weights to these observations. I had had the most model practice, but I think Miss Newton, who had but little, probably made quite as good an observation.

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that of Dr. Auwers as well as her own in the group, the mean becomes $11^h 16^m 50^s.67$. This, with a correction for the different nature of contact, would be considerably earlier than Mokattam, more so, perhaps, than the difference in factor would warrant.

At Rigaf, Lieut. Watson obtained a contact with a 2-inch glass at $20^h 8^m 35^s.9$ local mean time, which observation cannot be used till a more accurate longitude is obtained.

I cannot refrain from referring to some observations of accelerated egress likely to combine with the above.

At Melbourne, Mr. White with a $2\frac{3}{4}$ -inch glass got a contact entered as "thread of light destroyed," at $3^h 29^m 15^s$ local time. As he remarks that the apex of a black drop, which he terms "the Chinaman's cap," widened just as it joined the limbs, I assume this phase to be "black contact."

Mr. Ellery, with 8-in. glass, obtained a "distinct junction of limbs" at $3^h 29^m 20^s$. If this is, as I suppose, "black contact," Mr. Ellery's time agrees very well with Mr. White's, taking the difference of size of glasses into account.

With regard to interpretation of records of phases observed, I should think the model at Greenwich would furnish a valuable means of learning what phase observers recorded approximately if they set it to represent their contact.

Of the accordance of the Egyptian photographs made by Capt. Abney, R.E., it is premature to speak yet. They appear to be very good, and are now undergoing measurement.

My own double-image micrometer measurements look fairly accordant with my observation of contact, when entered on a curve, which is all I can say now.

The positions of the Egypt stations from which the transit was observed are as follow:—

Station.	Latitude N.			Longitude E.		
	°	'	"	h	m	s
Mokattam (Cairo)	30	1	46.32	2	5	6.32.
Abbasseeayah	30	4	38.13	2	5	8.66.
Suez	29	58	22.69	2	10	13.23.
Thebes	25	41	40 ±	2	10	32.76.
Rigaf	4	44	26.5	not accurately determined.		

With regard to the accuracy of these determinations, the longitude is of primary importance. The seconds of single results in each longitude operation, uncorrected for personal equations &c. were:—

Mokattam from Greenwich 6.55, 6.64, 6.61, and 6.55.

Suez from Mokattam 6.97, 6.90, 6.69, and 6.96.

Thebes from Mokattam 26.58, 26.48, 26.63, 26.50, and 26.59.

The observations for local time were made at Mokattam and

Suez with transit instruments in the meridian (that at Suez being a portable one). At Thebes, M. Döllen observed with a Russian transit in the vertical of the pole star. At Rigaf, Lieut. Watson used a sextant. The latitude of Mokattam was got by 3 determinations of stars near the meridian with a vertical circle; that of Suez with a zenith telescope. The Russian transit, having a vertical circle, was used for latitude at Thebes; and sextant observations were made at Rigaf.

With regard to telegraph work, I would call attention to the Thebes result, because I telegraphed it on December 9th as *bad* work, the signals being scarcely perceptible and slow; yet it turns out comparatively rarely that a single representative signal is found to differ from the mean of the group to which it corresponds by a tenth of a second.

As to time observations, there is little doubt that the Russian system of observing in the vertical of the pole star enables results to be got in a few hours that I should think can be obtained on no other system. As used by Mr. Gill at Suez for observing from two stations in the same night and for skirmishing purposes generally, I should think it unrivalled. For systematic observations in a fixed observatory I do not believe it offers sufficient advantages, even compared with a portable transit in the meridian, to counterbalance the evil of the increased labour necessary for the reduction of the observations.

In conclusion, I would call attention to the barbarity of leaving the telegraph longitude connexions to Melbourne and Sydney incomplete. Mr. Gill with Dr. Auwers and the German observers made a chain of determinations extending from Berlin to Bombay, and connected it with our Suez station. So that there now exists a double chain of longitude determinations from Greenwich to Suez; one *via* Berlin, and the other the Alexandria, Mokattam, Suez determination given above. From Suez to Bombay is then also well determined; and an exchange was made from Madras to Batavia long since, the results of which are with Mr. Pogson, I believe. If then a simple exchange were made between the fixed observations at Bombay and Madras, and the more difficult exchange arranged between Batavia and Melbourne by the employment of transmitting stations where the cable comes to land at Java and Cape Darwin, (where it would be sufficient to send observers with chronometers, not a single astronomical instrument being necessary), longitude connexions would exist between fundamental points in America, Europe, Africa, Asia, and Australia, besides which the elements for the Delisle method of application of the observations of the *Egress of Venus* would be thoroughly completed.